Solar Heating & Cooling Programme
INTERNATIONAL ENERGY AGENCY

TASK 27
BUILDING ENVELOPE COMPONENTS

Performance, durability and sustainability of advanced windows and solar components for building envelopes

Work Plan
October 1999

The objectives of this Task are to determine the solar, visual and thermal performance of materials and components, such as advanced glazing, for use in more energy efficient, comfortable, sustainable buildings, on the basis of an application oriented energy performance assessment methodology; and to promote increased confidence in the use of these products by developing and applying appropriate methods for assessment of durability, reliability and environmental impact.

The objectives shall be achieved in the following Subtasks:

Subtask A: Performance (Subtask Leader: Dick van Dijk, TNO, Netherlands)
Subtask B: Durability (Subtask Leader: Bo Carlsson, SP, Sweden)
Subtask C: Sustainability (Subtask Leader: Jean-Luc Chevalier, CSTB, France)

Subtask A will provide Subtask B with the definitions and characterisation methods of the performance of building envelope components and a description of their application. Subtask B will supply Subtask C with the evaluated failure modes and expected service life times of the investigated materials and components, which will also be included in the data-bases compiled by Subtask A, as well as the information about failure modes and environmental impact achieved by Subtask C.

Subtask A: Performance

Objectives

The objective of Subtask A is to further develop, structure and integrate the energy performance assessment methodology for windows and other solar building envelope components. Such a methodology will facilitate selection of components and enable performance comparison to be made. Particular emphasis will be given to the assembly and integration of high performance, novel and/or complex solar components into functional building envelope elements. Those assemblies may incorporate highly insulating glazing/frames, anti-reflecting or chromogenic switchable glazings, PV windows, solar shading devices and other daylight components. Data obtained by the Subtask will be provided in consistent and harmonised forms suitable for use for product comparison and selection and in building simulation tools. This work will also enable cost benefit studies to be performed and performance criteria to be defined for the work of Subtask B. The work will directly support manufacturers in improving product characterisation and specification.

Activities

Evaluation of the state-of-the-art of energy performance assessment in different participating countries and international standardisation

Solar, optical/visual and thermal performance properties of materials and building envelope components and their integration into assemblies will be defined which are relevant for the energy and daylight performance of a product or integrated assembly, and for the assessment of the impact of material degradation or component failure on the performance over time.

Assessment of performance in real use and for characterisation

Test conditions for measurement of the performance parameters of components will be determined and measurements will be made on materials and complete components. Physical models will be further developed that will allow prediction of the performance of components from material properties. The ultimate goal is to achieve coherent sets of widely applicable calculation methods supported by simple test methods. In this context, recommendations for standard calculation and test methods will be made to support work on international standards.

Development of a structured data base of components and systems

Product and component data have to be made available in consistent and harmonised forms, suitable for product comparison and selection and for simulation of performance in specific applications. The structured data base will comprise the range from certified data of established high performance products to results from research on prototypes of novel materials and products.

These activities will be carried out within 3 different projects:

Project A1: Generic energy performance assessment methodology

Objectives

- Comparison and further development of energy performance assessment methodologies on windows and other solar facade components, their assembly and integration into building envelope elements.
- Set up a data structure of components and facade elements in a form suitable for product comparison, for product selection and for simulation of performance in specific applications.
- Identification of performance criteria for durability and service lifetime prediction as support to Project B1.

Activities

1. State of the art: overview of existing performance assessment methodologies for windows and other solar building envelope components
   - Component characterisation, labelling schemes, simplified methods, advanced codes, test methods, international standards
   - Description of scope, appropriateness for new developments, user-friendliness, integration aspects
2. Definition of appropriate terminology and screening of performance indicators of windows and other high performance solar components and their assemblies which are relevant for practice (in co-operation with projects A2-A3)
3. Enhancement and augmentation of a coherent performance assessment methodology
4. Definition of relevant conditions for testing and calculating and requirements from energy performance methodology
   - relevance for practical design
   - reflection of advanced features
   - conditions for the calculation and/or measurement of characteristic values and required accuracy
5. Setting up a structured data-base of components and facade elements to present data in a consistent and harmonised form, suitable for product comparison and selection and for simulation of performance in specific applications.
6. Use of data in window and building simulation tools
   - data extrapolation and interpolation required to exchange data with/between calculation tools
   - description of necessary algorithm modifications, additions and recommendations from the product-specific projects A2-A3

- collaboration with developers of internationally used software tools to stimulate implementation of recommended improvements
- definition and simulation of case studies

7. Support of Subtask B by the definition of performance criteria and sensitivity studies of degradation effects on energy performance and cost-benefit (in co-operation with projects A2-A3)
   - investigation of relevant performance indicators with respect to performance
   - estimation of degradation impact on performance
8. Documentation and recommendations for international standardisation; final report

Time-scale / Milestones

Activity	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1) Overview																
2) Terminology																
3) Enhancement																
4) Test conditions																
5) Data base																
6) Simulation																
7) Degradation																
8) Documentation																

Δ^1 Δ^2,Δ^3 Δ^4 Δ^5 Δ^7 Δ^6 Δ^8

Δ^1 State of the art report on existing methodologies
Δ^2 Extended report on performance indicators and terminology
Δ^3 Preliminary energy performance assessment methodology for Projects A2-A3 and B1
Δ^4 Improved energy performance assessment methodology
Δ^5 Definition of appropriate conditions for testing and calculation
Δ^6 Structured data base, data and algorithm modifications
Δ^7 Sensitivity studies report
Δ^8 Recommendations for international standards and final project report

Deliverables

- Improved and coherent energy performance methodology
- Structured database of components and integrated systems in consistent and harmonised forms suitable for product comparison and selection and for simulation of performance in specific applications
- Recommended calculation and test procedures for solar and thermal performance parameters in support of international standards development.

Link to other projects

Project A1 will directly support the projects A2-A3 by providing a platform for developing a congruent and coherent energy performance assessment methodology and structured database suitable for the comparison and selection of different types of solar building envelope components. It will directly support Subtask B1 with sensitivity of performance for degradation effects.

The work in Subtask A, and consequently in this project A1, is closely linked to international standardisation activities (e.g. ISO TC 163 WG14 and joint WG2 (windows) , TC 160 (glazing) and the corresponding groups in CEN: TC89 WG7, WG8 and TC129 WG6 & WG9).

The project has links with recent or current international research projects as WIS, ALTSET, REVIS, IMAGE, etc. The links will be effectuated by the participation of representatives of these projects.
Similar: activities in USA, Canada and Australia (e.g. NFRC, ASTM).

Lead country Germany (FhG-ISE)

Project A2: Chromogenic Glazing

Objectives

- Define necessary solar, optical and electrochemical properties of chromogenic glazings
- Develop improved electrochemical and solar/optical performance characterisation procedures
- Harmonisation of performance definition
- Determination of chromogenic window solar/thermal performance

Activities

1. State-of-the-art review of market potential of chromogenic glazings
2. Comparison of performance characteristics of electrochromic, gasochromic and thermotropic glazings
3. Optical and electrochemical measurement of materials and devices
4. Modelling of device and component performance starting from materials properties
5. Measurement of large area chromogenic window solar, thermal, visual and energy performance
6. Definition of measurement test procedures
7. Monitoring of test cell experiments
8. Investigation of control strategies
9. Case study of electrochromic facades (if possible)

Time-scale / Milestones

Activity	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
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Δ^1 Market potential review

Δ^2 Performance definition report

Δ^3 Chromogenic glazing properties and energy performance report

Δ^4 Recommendations for measurement test procedures

Δ5 Test cells report

Δ6 Control strategies report

Δ7 Case Study report

Δ8 Final project report

Deliverables 5 and 6 may be merged to one report

Deliverables

- Performance data of chromogenic glazing systems
- Recommendations for building integration and control
- Standardised performance declaration procedure

Link to other projects

Project A1: Performance assessment methods

Project B2: Durability and reliability of chromogenics

Lead country: UK (Brookes Univ.)

Project A3: Solar building components and integrated assemblies

Objectives

- Determine thermal performance and improve models of selected window and other solar components and their integration into building envelope assemblies or facade systems
- Develop recommendations for standardised test and calculation procedures for the integrated thermal/solar/daylighting performance of products and building envelope elements with solar components such as high performance windows (glazings/frames), light redirecting components and solar control elements (incl. blinds).

Activities

1. Selection of solar building components and assemblies on the basis of main issues of investigation, e.g.:
   - solar control devices (in particular lamella type of shading) and their integration
   - double envelope systems
   - TI-facades
   - daylight redirecting systems
   - high performance glazing/window/wall assemblies
2. State of the art in international standardisation (ISO, CEN)
3. Identification and specification of major issues for investigation (complex optical/visual transmittance/reflectance, air flow and heat exchange in cavities with integrated solar control elements (e.g. blinds), dynamic effects (overheating), edge effects (e.g. window/wall), product daylight indices, building envelope integration
4. Indoor / outdoor measurement and modelling of components and systems
5. Define / improve test procedures, algorithms and performance parameters
6. Recommendations for international standardisation (calculation and test methods, standard conditions)

Time-scale / Milestones

Activity	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
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Δ^1 Performance data report
Δ^2 Results of testing and modelling
Δ^3 Building integration recommendations
Δ^4 Recommendations for thermal/solar performance assessment
Δ^5 Final project report

Deliverables

- Improved test and calculation methods
- Thermal/solar performance data of selected window/solar components and assemblies
- Recommendations for building application and integration
- Recommendations for standardised performance assessment procedures

Link to other projects

Project A1: performance assessment methods
IEA SH&C Task 21, 28
EU-Projects: ADOPT, ALTSET, WIS, REVIS
NFRC
National projects

Lead country: Switzerland (EMPA)

Subtask B: Durability

Objectives

There are two main objectives. The first is to develop a general framework for durability test procedures and service lifetime prediction (SLP) methods that are applicable to a wide variety of advanced optical materials and components used in Energy Efficient Solar Thermal and Buildings applications. The second is to apply the appropriate durability test tools to specific materials / components to allow prediction of service lifetime and to generate proposals for international standards.

Activities

The activities are structured within two major parts. These are ”Durability Assessment Methodology Development” (B1) and ”Durability Test Procedures for Materials and Components (B2, B3, B4)”. Within B1, a review of existing durability test procedures and SLP methodologies will be performed. Next, a general outline of methodologies applicable to a variety of specific materials (identified by B2, B3, and B4 and leading to individual case studies) will be drafted. The general approach will be adapted to these specific materials/devices/components/systems. Through interactions with the case study projects, revisions to the general methodology will be made. In parallel with these revisions, the general methodology will be validated. This will be accomplished by applying the methodology to a material for which real-world data are available and demonstrating that the predicted time-dependent performance based on accelerated test results agrees with real-world ageing behaviour. After the general methodology has been successfully adapted to a number of specific materials and its validity has been shown, the final version will be documented. Standardised analysis and testing protocol tools will also be developed throughout this process. These will include standardised data formats, data base structures, and computer algorithms for data analysis, along with hardware instrumentation specifications for monitoring and measurement.

The list of materials and components to which the B1 methodology will be adapted will include

- glazing incorporating thermotropic coatings, electrochromic materials, and gasochromic materials
  (Project B2)
- anti-reflective (AR) and polymeric glazing, reflectors, and solar facade absorbers
  (Project B3)

- edged sealed and breathing glazing units, complete windows (Project B4)

Applications

To achieve successful and sustainable commercialisation, solar building products must meet three important criteria, namely minimum cost, maximum performance, and demonstrable durability.

Durability assessment directly addresses all three segments of this triad. First, it permits analysis of life cycle costs by providing estimates of service lifetime, O&M costs, and realistic warranties. Understanding how performance parameters are affected by environmental stresses (for example by failure analysis) allows improved products to be devised. Finally, mitigation of known causes of degradation directly results in increased product longevity. Thus, accurate assessment of durability is of paramount importance to assuring the success of solar thermal and building products.

Subtask B requires input from Subtask A in terms of criteria for measuring the performance and for microclimate monitoring. It provides information that allows Failure Modes and Effect Analysis (FMEA) to be performed on system level by Subtask C.

Project B1: Durability assessment methodology development

Objectives

The objective of this Project is to develop a general methodology of test procedures for the assessment of durability, reliability and service lifetime prediction (SLP) of materials and devices used in solar thermal and building applications. The methodology will be sufficiently robust that it can be adapted to a wide variety of specific materials systems that are of interest.

Activities

1. Review the literature on existing durability test procedures and SLP methodologies and develop a generalised methodology that are applicable to the variety of advanced optical materials and components used in Energy Efficient Solar Thermal and Buildings applications
2. Select candidate materials to be used for validation purposes
3. Perform accelerated exposure tests of the chosen materials and collect real-world exposure data for these materials for validation purposes

4. Validate methodology by demonstrating agreement, based on accelerated test results, between predicted time variations and actual measurements of material's performance during real-world in-service conditions
5. Facilitate application of the general methodology to additional specific materials systems of interest to Task 27 (Projects B2, B3, and B4)
6. Iteratively refine the general methodology based upon individual requirements of specific materials systems
7. Provide input to Subtask C for FMEA on complete systems
8. Prepare recommended standard methods for durability and lifetime assessment of materials and components for solar and building applications
9. Document results and accomplishments

Time-scale / Milestones

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Δ^1 Methodology test procedures defined

Δ^2 Methodology validated

Δ^3 Methodology successfully adapted to additional materials systems

Δ^4 Draft standard methodology defined and results documented

Deliverables

- A validated methodology for durability and lifetime assessment
- Support for the durability projects B2, B3, and B4 by providing a congruent methodology of standardised test protocols and data analysis procedures
- Standard test procedures and recommended methods for international standardisation.

Link to other projects

Project B1 will make use of the material-specific performance characterisation procedures developed in Subtask A to allow accurate measurement of appropriate performance parameters to assess durability (loss of performance with time). It will directly support the durability projects B2 and B3 by providing a congruent methodology of standardised test protocols and data analysis procedures. Finally, Project B1 will provide information to Subtask C to allow failure modes and effect analysis (FMEA) on complete systems.

Lead countries: Sweden (SP), Germany (ISE) and United States (NREL)

Project B2: Durability and reliability assessment of switchable materials and devices (chromogenics)

Objectives

The general objective of this project is to assess the durability and reliability, under service conditions, of a variety of switchable materials and devices including those containing electrochromic, gasochromic, and/or thermotropic layers. Such materials may have application for both building facades and solar thermal collector systems.

Activities

1. Adaptation of the methodology of the durability test procedures developed in project B1, taking experience of industrial suppliers and testing laboratories on chromogenic durability testing and durability testing standards for related commercially available products (e.g. sealed glazing units, laminated glazing, solar thermal collector systems) into account.
2. Definition of quantitative measures of the critical performance characteristics (for example, solar transmittance in the clear versus switched state) associated with the various chromogenic materials of interest and dependence on switching stimulus (such as switching temperature for thermotropics, gas concentration for gaschromics, and voltage waveform for electrochromics) in collaboration with Project A2.
3. Measuring and modelling of microclimatic conditions associated with realistic and representative service conditions experienced by the various chromogenic devices.
4. Determination of the effect of changes in the critical characteristics on system performance, particularly with regard to energy yields and overheating, in collaboration with Project A2.
5. Specification and preparation of test samples
6. A number of uncertain issues associated with durability testing of chromogenic materials will be identified and addressed by collaborative (round robin) testing. For example, eighteen specific unknown aspects about the durability testing of

electrochromic windows are discussed by Czanderna et al (Solar Energy Materials & Solar Cells 56, 1999, pp. 419-436).

7. Accelerated ageing tests will be carried out, in which the chromogenic layers are incorporated into realistic constructions (for example, thermotropic layers between two panes of glass or in a transparent insulating module; gasochromic and electrochromic layers incorporated into glazed units, etc.) and are subjected to different combinations of raised temperature, radiation and humidity levels. The switchable property must be taken into account both by testing the samples at different, constant states (i.e. clear vs. opaque for thermochromic; bleached vs. coloured for gasochromic and electrochromic) and by performing cycling tests. In addition, standard national weathering tests for authorisation of glazed building products will be applied.
8. Outdoor tests will be performed in collaboration with Project A2, in which the chromogenic layers are exposed as components of complete systems to environmental conditions, preferably at several different locations having appropriate meteorological and radiometric monitoring instrumentation.
9. Modelling of the ageing performance
10. Development of an algorithm for service life prediction
11. Definition of recommended test procedures
12. Dissemination of information by publication, conference participation

Time-scale / Milestones

Activity	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
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Δ^1 Adaptation of durability assessment methodology to specific chromogenic requirements

Δ^2 Completion of first series of accelerated ageing tests
Δ^3 Comparison and validation with results of outdoor testing
Δ^4 Completion of second series of accelerated ageing tests
Δ^5 Comparison and validation with results of outdoor testing
Δ^6 Service life prediction algorithm developed
Δ^7 Recommended test procedure defined

Deliverables

- Durability assessment methodology appropriate to chromogenic components
- Validated ageing model for chromogenic components
- Service life prediction algorithm for chromogenic components
- Recommended test procedure for chromogenic components

Link to other projects

The determination of critical characteristics, their effect on energy performance, and outdoor measurements will draw on the experience gained in measuring chromogenic materials within Project A2. This project is directly linked to Project B1 in which the methodology for the durability and reliability assessment is developed.

Lead country: Germany (gasochromics and thermotropics) -Interpane / United States (electrochromics) -NREL

Project B3: Durability and reliability assessment of static solar materials

Objectives

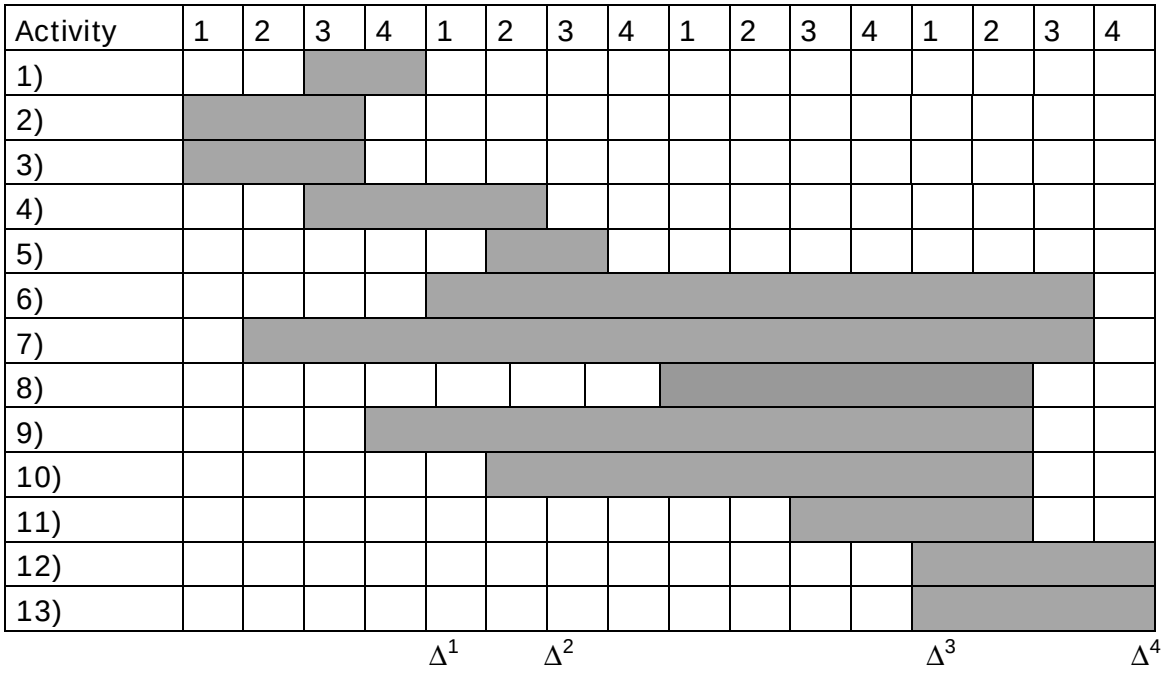
The general objective of this project is the assessment of the durability, reliability and service life of static solar materials. Materials to which the B1 methodology will be adapted will include anti-reflective (AR) and polymeric glazings, reflectors, and solar façade absorbers. Work on these will be performed in form of case studies.

Activities

1. The durability methodology test procedures developed in Project B1 will be adapted for the selected kinds of materials
2. Representative and realistic test samples will be identified and prepared
3. Relevant performance parameters will be defined and characterisation procedures (input from Subtask A) will be established

4. Accelerated screening tests will be performed to
   a) identify what stress variables contribute to performance degradation of the selected materials
   b) determine reasonable levels of these stresses for further testing
5. A test plan will be written to optimise experimental design
6. Accelerated exposure tests
7. Real-world exposure tests
8. Correlations will be derived between accelerated and real-world exposure test results
9. Failure analysis will be performed to determine failure mechanisms and failure modes
10. Based on these correlation and failure analysis, a model will be developed that relates degradation to stress-driven damage functions
11. This relationship will be used to predict service lifetime
12. Recommended standard methods for durability assessment of specific materials for solar collector applications will be drafted
13. Results and accomplishments will be documented

Time-scale / Milestones



Δ^1 Test procedures defined and implemented

Δ^2 Accelerated screening tests completed

Δ^3 Feasibility of service life prediction with the developed test procedures approved

Δ^4 Standard test procedures defined and dissemination started

Deliverables

- Durability of case study materials
- Defined failure modes.
- Degradation analysis model for service life prediction.
- Drafted test procedures for proposal of international standards.

Link to other projects

Optical and thermal characterisation methods will be required from Subtask A. This project is directly linked to project B1 in which the methodology for the durability and reliability assessment is developed. Durability results (degradation of performance) will be provided to Subtask C.

Lead country: Switzerland (SPF)

Project B4: Durability and reliability assessment of windows and glazing units

Objectives

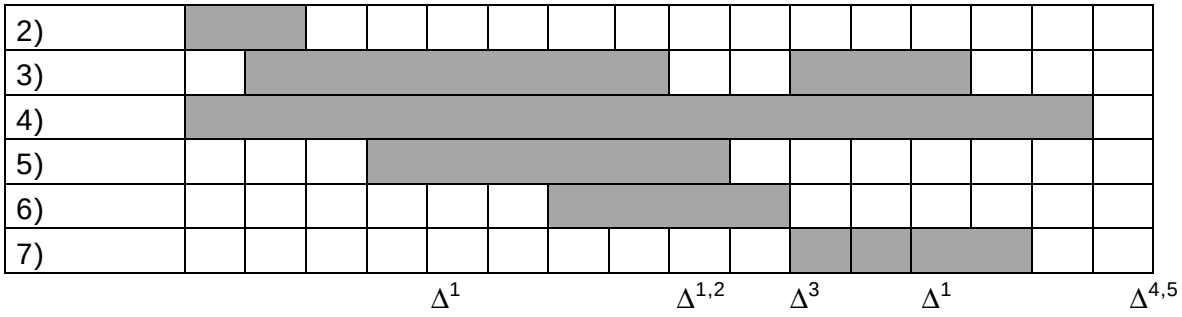
The general objective of the project is the assessment of the durability and reliability (fitness for use) of selected window systems (e.g. highly insulating frames, glazing units ..). This requires accumulation of long-term performance data, as well as measured and calculated results of hygro-thermal behaviour. Durability / reliability assessment procedures will be documented.

Activities

1. Adaptation of the methodology of the durability test procedures developed in Project B1
2. Selection of systems to be investigated (e.g. TIM-elements, glazing units, advanced windows)
3. Accelerated indoor testing
4. Long term monitoring (outdoor tests), comparison with accelerated ageing
5. Device modelling / validation (heat, air, moisture, dust)
6. Investigation of critical conditions and design parameters
7. Definition of durability / reliability assessment procedures

Time-scale / Milestones

Activity	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1)																



Δ^1 Yearly evaluation of collected data
Δ^2 Test data report
Δ^3 Design guide lines
Δ^5 Comparison of natural & accelerated ageing data
Δ^6 Final project report

Deliverables

- Long term performance data of selected window elements
- Requirements for the reliability of advanced windows
- Improved thermal and microclimatic device models
- Durability / reliability assessment procedures
- Supporting data for Subtask C on failure modes and effect analysis

Subtask C: Sustainability

Objectives

The sustainability of solar building envelope components will be addressed by investigating, identifying and applying to examples relevant methodologies and criteria in two of its main fields which are environmental impact assessment and service life anticipation.

Activities

As this subtask is dealing with relatively new concepts, which are not yet completely defined and harmonized at an international level, a lot of work will be needed on information collection. The first step will consist of a review of internationally agreed sustainability indexes, and the way they address particularly environmental impacts and service life prediction. Then the work will be split in two separate projects:

Environmental impact assessment (project C1) will be developed in three steps. The first one is a state-of-the-art-study, in order to collect existing knowledge within the participating

countries, regarding: tools available (from LCA to the most simplified tools), studies already performed, national actions and priorities, needs expressed by the industry and the specifyiers. The second step will undertake methodological aspects (boundary options , data quality, effects and limitation of simplified approaches, priorities, link with performance and durability, expression and format of the results, and proceed towards an harmonized format for communication on environmental characteristics. The last step, (whose success is strongly dependent on the contributions by industry), will demonstrate the applicability of the methodology by experiencing three examples (suggestions are: comparison between an advanced and a traditional double glazing unit, sensitivity study on a solar collector, objective investigation of window frames, but the final choice will depend on industry and users expectations).

Failure mode analysis (Project C2) is a multiple-scale exercise. The durability approach developed in Subtask B contributes to the project by providing information at the material and component level. The extrapolation over time of decreasing performance after aging processes permits an assessment of estimated service lifetime, “nominal” life duration. But premature failures of the products at the component or at the system scale must be considered in addition. The suggested methodology is the application of the Failure Mode Effects and Analysis tool (FMEA). Widely used in industries, FMEA will be adapted to windows and solar devices, and recommended for checking the risks of failure at the component scale. In a second phase FMEA will be applied to several examples to allow the identification of possible premature end of the predicted service life(before the nominal value). Provided that industrial partners will participate, and in conjunction with project B4, the possible case studies could deal with a whole window, a transparent insulation element, and a double facade unit.

Project C1: Environmental impact assessment

Objectives

- Survey of the existing knowledge in the participating countries in the field of environmental impact of building products, and particularly glazing and solar components
- Assessment of an appropriate format for communicating on environmental characteristics, adapted to the industry needs and to the users (specially specifiers) demand
- Application of the methodology to selected products

Activities

1. Collect information on tools for environmental quality (EQ) assessment and studies related to glazing, windows and solar components
2. Compile the needs expressed by the manufacturers and users in terms of environmental characteristics
3. Analyze the two previous surveys in terms of major questions raised, relevant criteria, priorities, harmonization needed
4. Analyze the methodological aspects for communication of environmental characteristics (data quality, boundary options, effects of simplifications, extended functional unit including performance, service life duration and end of life scenarios)
5. Assess an harmonized format for communication
6. Application 1: comparing an advanced double glazing unit to a traditional one
7. Application 2: sensitivity study on a solar collector
8. Application 3: objective investigation of the window frames (optional)
9. Drafting the final report

Time-scale / Milestones

Activity	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
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Δ^1 State-of-the-art report

Δ^2 Harmonized format

Δ^3 Application reports

Δ^4 Final project report

Links

- IEA SH&C: Task 27 Projects A1, B1
- IEA BCS: Annex 31 and follow-up if any
- European networks: ENED, CRISP, PRESCO

Project leader: France (CSTB)

Project C2: Failure mode analysis

Objectives

- Investigation the durability and reliability approach at the component and system scale: terminology, data collection, methodology, experimentation.
- information on the service life prediction (SLP) existing methodologies (both in correlation with the B1 and B4 projects)
- Survey of the Failure Mode Effects Analysis (FMEA) expertise in the group, and its adaptation to glazing, windows and solar components for identification of premature termination of the service life
- Application of the SLP and FMEA adapted methodology to selected products (nominal service life prediction and anticipation of premature termination).

Activities

1. Harmonization of the terminology
2. Review of the durability approaches at the component and system scale
3. Selection of a service life prediction methodology by putting together the type of results expected from subtask B and data available at the component and system scale
4. Introduction of the FMEA concept.
5. Adoption of the FMEA methodology to glazing, windows and solar components for anticipating premature termination of the service life.
6. Application 1: calculate a nominal service life and anticipate premature termination for a window
7. Application 2: calculate a nominal service life and anticipate premature termination for a solar component
8. Drafting the final report

Time-scale / Milestones

Activity	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
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Activities 6 and 7 are strongly dependent on the industry involvement

Δ^1 Terminology report

Δ^2 Methodology report: nominal service life prediction and anticipation of premature termination

Δ^3 Application reports

Δ^4 Final project report

Links

Projects, B1, B4

ISO-TC59-SC14, and CIB W 80 (Service life planning)

Project leader: France (CSTB)